Aspects of rarity in the Australian flora

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Summary

Elsol, James A. (1993). Aspects of rarity in the Australian flora. *Austrobaileya* 4(1): 1–6. Four regional floras of eastern Australia each with over 1 500 species reveal superorder compositions similar to that for the whole of Australia. Of the 30 superorders known to occur in Australia, three to seven account for 75% of the concentration of dominance within the floras. Commeliniflorae consistently contributes at least 10% of species in a region. Fabiflorae, Myrtiflorae, Liliiflorae, Malviflorae and Asteriflorae may each contribute up to 10% or more. Eighteen superorders consistently contribute less than 5% each. One superorder, Loasiflorae has not been recorded from Australia.

Twenty-two percent of Australia's flora has been recorded as rare. Percentage rarity recorded within superorders varies up to 37% but appears unrelated to superorder size.

Future research into rare taxa depends on whether priority is given to groups accounting for high percentages of rare species within a flora, eg Myrtiflorae with 15% of Australia's rare species, or those taxa with a high degree of rarity, e.g. 37% of palms (Areciflorae) are rare but constitute only about 1% of Australia's rare species.

Keywords: rarity – Australian flora, floristic composition, superorders – Angiosperms.

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Introduction

Attention continues to focus on rarity in the world's biota. Much of the biological attention has been directed towards recognising those taxa that are rare and determining whether they are threatened or endangered (Reveal 1981). What has seemingly not been addressed though, is whether rarity is evenly distributed across the major groups of taxa. The present investigation addresses this issue by examining the composition of some floras of eastern Australia.

Sources of data

The intention of this investigation is to reveal trends rather than provide numerically accurate syntheses. For the latter more detailed data may be required.

An overview of Australia's flora was gained from Morley and Toelken (1983) and compared with the following four more restricted floras in eastern Australia: Moreton refers to the coastal part of south-eastern Queensland described by McDonald and Elsol (1984); Port Curtis is the flora described by Batianoff and Dillewaard (1988) from around Rockhampton in central coastal Queensland; Northern Territory comprises the flora of the Darwin and Gulf region botanical province as described by Dunlop (1987) and Victoria comprises the flora of Victoria as described by Forbes *et al.* (1984). Data on rare species were obtained from Briggs and Leigh (1988) for Australia, Victoria and Northern Territory, from HERBRECS (Queensland Herbarium records) for Moreton and from Batianoff and Dillewaard (1988) for Port Curtis.

Naturalised exotic taxa were ignored.

Superorders follow the system of Dahlgren (1980).

Distribution of rarity within flora

A common concept of species rarity is that taxa may be rare if numerically few or of limited geographic extent.

Rarity may also occur in taxonomic ranks higher than species in the same way as species rarity exists, and also in the sense that a particular higher taxon may comprise few species and therefore constitute only a rare component of a

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flora. For example, aroid and ginger floras, with about 25 species each, are rare in the Australian angiosperm flora which totals about 14 500 species.

***Composition of the Australian flora*:** In the four floristic censuses investigated, 20–28 superorders are commonly present (**Tables 1 & 3**). Superorder compositions of the regional floras do not differ significantly from that of Australia at 5% level (Kolmogorov-Smirnov test, Siegel & Castellan 1988). Superorders accounting for 90% of Australia's flora and their major constituent families are listed in **Table 2**.

Table 1. Superorder composition of the Australian angiosperm flora ranked from highest to lowest representation. Arrows indicate added variability observed in four eastern Australian floras (Northern Territory to Victoria).

Percentage of species within flora				
10% or >	5–9%	1–4%	0–1%	Absent
Commeliniflorae				
Fabiflorae ——>				
Myrtiflorae ——>				
	< —— Liliiflorae ——>			
	< —— Malviflorae ——>			
	Proteiflorae ——>			
	Lamiiflorae ——>			
	< —— Asteriflorae ——>			
	Gentianiflorae ——>			
		< —— Rutiflorae		
		< —— Caryophylliflorae		
		Corniflorae		
		Solaniflorae		
		Araliiflorae		
		Violiflorae		
		Santaliflorae		
		Magnoliiflorae ——>		
		Rosiflorae ——>		
		Theiflorae ——>		
			< —— Primuliflorae	
			< —— Alismatiflorae	
			Areciflorae	
			Ranunculiflorae	
			Polygoniflorae	
			Nymphaeiflorae	
			Ariflorae	
			Zingiberiflorae	
			Balanophoriflorae	
			Podostemiflorae	
			Triuridiflorae	
				Loasiflorae

Table 2. Superorders accounting for 90% of Australia's angiosperm flora and major constituent families

1. Commeliniflorae:	Cyperaceae, Poaceae
2. Fabiflorae:	Mimosacee, Fabaceae
3. Myrtiflorae:	Myrtaceae
4. Liliiflorae:	Liliaceae, Orchidaceae
5. Malviflorae:	Dilleniaceae, Malvaceae, Euphorbiaceae
6. Proteiflorae:	Proteaceae
7. Lamiiflorae:	Acanthaceae, Lamiaceae, Scrophulariaceae, Verbenaceae
8. Asteriflorae:	Asteraceae, Campanulaceae
9. Gentianiflorae:	Goodeniaceae, Rubiaceae, Apocynaceae, Asclepiadaceae
10. Rutiflorae:	Rutaceae, Sapindaceae
11. Caryophylliflorae:	Amaranthaceae, Chenopodiaceae, Caryophyllaceae
12. Corniflorae:	Epacridaceae
13. Solaniflorae:	Solanaceae
14. Araliiflorae:	Apiaceae
15. Violiflorae:	Brassicaceae, Capparaceae

One superorder, Commeliniflorae, constantly contributes 10% or more species to the four regional floras studied. A further five superorders, Fabiflorae, Myrtiflorae, Liliiflorae, Malviflorae and Asteriflorae may each contribute to 10% or more in some of the regional floras.

Eighteen superorders consistently contribute less than 5% each.

One superorder Loasiflorae, has not been recorded from Australia.

***Relationship of rare species numbers to size of parent superorder*:** Rare species have been recorded as comprising as much as 22% of Australia's flora (Briggs & Leigh 1988). By excluding Podostemiflorae with about one species, rarity of species within superorders varies between 2% (Polygoniflorae) and 37% (Areciflorae) and mostly lies within 10% and 30%. The percentage varies regionally and appears uncorrelated with the size of the superorder ($r < 0.1$).

None-the-less interesting trends are observed for some of the superorders (**Table 3**).

1. Commeliniflorae, Caryophylliflorae: The proportions of rare species within Australia and the four regional floras accounted for by these superorders are lower than the proportions these superorders have when all species are considered.

2. Myrtiflorae, Liliiflorae, Malviflorae, Proteiflorae: The proportions of rare species within Australia and the four regional floras accounted for by these superorders are mostly higher than the proportions these superorders have when all species are considered.

3. Fabiflorae: Though there is regional variation, rarity of the superorder's species within the Australian flora is in the same proportion that the superorder has when all species are considered.

4. Lamiiflorae: Compared to the other floras examined, the proportions of rare species in Port Curtis and Northern Territory floras accounted for by the superorder are higher than the proportions this superorder has when all species are considered.

5. Gentianiflorae, Solaniflorae, Violiflorae: Compared to the other floras examined, the proportions of rare species in Port Curtis accounted for by these superorders are higher than the proportions these superorders have when all species are considered.

Table 3. Composition of Australian and four eastern Australian angiosperm floras

Superorders are those of Dahlgren (1980). Column 1 contains percentages of all species (A); column 2 rare species (R). Superorders above the line collectively contribute 75% or more to the concentration of dominance. (. = <1%)

Australia	A	R	Moreton	A	R	Victoria	A	R	Port Curtis	A	R	Northern Territory	A	R
1. Commeliniflorae	13	7	Commeliniflorae	15	4	Commeliniflorae	18	12	Commeliniflorae	22	8	Commeliniflorae	25	14
2. Fabiflorae	12	12	Liliiflorae	11	17	Asteriflorae	14	14	Fabiflorae	12	4	Fabiflorae	13	9
3. Myrtiflorae	10	15	Fabiflorae	10	7	Liliiflorae	11	12	Malviflorae	11	10	Malviflorae	12	14
4. Liliiflorae	7	8	Myrtiflorae	9	14	Myrtiflorae	7	9	Myrtiflorae	7	8	Myrtiflorae	8	12
5. Malviflorae	7	8	Rutiflorae	7	9	Malviflorae	6	9	Gentianiflorae	6	12	Gentianiflorae	7	6
6. Proteiflorae	6	9	Malviflorae	6	7	Caryophylliflorae	6	2	Rutiflorae	6	10	Lamiiflorae	4	15
7. Lamiiflorae	6	5	Asteriflorae	6	7	Fabiflorae	6	14	Asteriflorae	5	4	Caryophylliflorae	4	1
8. Asteriflorae	6	5	Gentianiflorae	6	5	Lamiiflorae	5	4	Liliiflorae	5	8	Solaniflorae	4	2
9. Gentianiflorae	6	4	Lamiiflorae	4	5	Gentianiflorae	5	1	Lamiiflorae	4	8	Liliiflorae	4	8
10. Rutiflorae	4	6	Magnoliiflorae	3	4	Rutiflorae	4	4	Caryophylliflorae	4	2	Rutiflorae	3	2
11. Caryophylliflorae	4	2	Corniflorae	3	4	Araliiflorae	3	2	Solaniflorae	4	6	Asteriflorae	3	0
12. Corniflorae	4	5	Proteiflorae	3	6	Corniflorae	3	2	Santaliflorae	3	2	Santaliflorae	1	1
13. Solaniflorae	2	1	Santaliflorae	3	1	Proteiflorae	3	7	Violiflorae	2	6	Corniflorae	1	4
14. Araliiflorae	2	2	Araliiflorae	2	1	Violiflorae	2	4	Magnoliiflorae	2	0	Proteiflorae	1	4
15. Violiflorae	2	2	Caryophylliflorae	2	1	Solaniflorae	2	1	Araliiflorae	2	0	Violiflorae	1	1
16. Santaliflorae	2	1	Violiflorae	2	0	Alismatiflorae	2	0	Proteiflorae	2	8	Alismatiflorae	1	0
17. Magnoliiflorae	1	2	Solaniflorae	2	0	Santaliflorae	1	1	Rosiflorae	1	2	Areciflorae	1	3
18. Rosiflorae	1	1	Alismatiflorae	2	0	Rosiflorae	1	1	Corniflorae	1	0	Magnoliiflorae	1	0
19. Theiflorae	1	1	Rosiflorae	2	3	Ranunculiflorae	1	1	Alismatiflorae	1	0	Araliiflorae	1	1
20. Primuliflorae	.	1	Primuliflorae	1	3	Polygoniflorae	1	0	Ranunculiflorae	1	0	Theiflorae	1	1
21. Alismatiflorae	.	.	Ranunculiflorae	1	2	Theiflorae	1	0	Polygoniflorae	.	0	Primuliflorae	1	0
22. Areciflorae	.	1	Polygoniflorae	1	1	Magnoliiflorae	.	0	Nymphaeiflorae	.	0	Ariflorae	1	0
23. Ranunculiflorae	.	.	Ariflorae	.	0	Ariflorae	.	0	Ariflorae	.	0	Nymphaeiflorae	.	0
24. Polygoniflorae	.	.	Theiflorae	.	0	Primuliflorae	.	0	Theiflorae	.	2	Ranunculiflorae	.	0
25. Nymphaeiflorae	.	.	Nymphaeiflorae	.	0	Nymphaeiflorae	.	1	Areciflorae	.	0	Polygoniflorae	.	0
26. Ariflorae	.	.	Areciflorae	.	0	Areciflorae	.	0	Zingiberiflorae	.	0	Rosiflorae	.	0
27. Zingiberiflorae	.	.	Zingiberiflorae	.	0							Podostemiflorae	.	0
28. Balanophoriflorae	.	0										Zingiberiflorae	.	0
29. Podostemiflorae	.	.												
30. Triuridiflorae	.	0												

***Concentration of higher taxa diversity*:** The degree of concentration or dominance in a community or flora may be indicated by Simpson's (1949) Index, in this case estimated by $\Sigma\ p_i^2$ where p_i is the proportion of a flora accounted for by a superorder. The index measures the probability that two individuals selected at random from a sample will belong to the same taxon. Values of the index calculated from the proportions of the superorders within the floras investigated are shown in **Table 4**. Three to seven superorders collectively contribute 75% or more to the concentration of dominance in the floras examined, with Commel-iniflorae and Fabiflorae common to all five.

Table 4. Dominance of angiosperm superorders and constituent rare components in Australia and some eastern Australian floras. C = Simpson's Index

	Total flora			Rare component		
	C	$\frac{1}{C}$	Flora size 000's	C	$\frac{1}{C}$	Flora size × 0.1
Australia	0.076	13.3	14.5	0.081	12.4	320
Moreton	0.076	13.3	1.7	0.087	11.5	12
Victoria	0.089	11.2	2.7	0.097	10.3	18
Port Curtis	0.097	10.3	1.9	0.078	12.8	5
Northern Territory	0.113	8.9	2.1	0.099	10.1	9.5

None of the regional floras examined shows dominance less than expressed for Australia as a whole. The highest concentration of dominance is expressed in the Northern Territory and is associated with that flora's high percentage (25%) of Commeliniflorae (**Table 3**). A similar trend is also well developed in the Port Curtis district.

Simpson's Index varies inversely with heterogeneity. The reciprocal of the index may therefore be interpreted as the number of equally represented taxa that would be required to produce the observed heterogeneity (Peet 1974) and shows a range of 9–13 superorders of the total of 30 for Australia. The rare components of the floras of Australia, Moreton and Victoria are concentrated slightly more than are the superorders when all species are considered (**Table 4**). For Port Curtis and Northern Territory the rare species are more evenly spread across the superorders. This difference may be attributable to the lower species numbers present in the latter two floras.

Discussion and implications

Observations of percentage rarity within taxa and the representations of those taxa within floras suggest differences in the way major evolutionary lines are dispersed. For example rarity in the Commeliniflorae and Caryophylliflorae is low relative to the total contributions these two taxa have in Australia, whereas in Myrtiflorae and Proteiflorae rarity is relatively high. This observation is consistent with Commeliniflorae and Caryophylliflorae generally having wider geographic ranges than species of Myrtiflorae, Malviflorae and Proteiflorae, that is changes in species composition over distance or environmental gradient is generally higher for the latter three taxa. Pollination, whether by wind or animal vector, may be contributory.

In the flora of Australia the number of species per superorder ranges from one to nearly 2000. From present observations, percentage rarity within them appears unrelated to their

size but is widespread across the superorders. Accordingly, as priorities for vegetation conservation often relate to the presence of rare species, it is important to realise that the greatest diversity in genetic material that would be conserved by rare species conservation occurs when those species are from a diverse range of higher taxa rather than a narrow range. This may be important when ranking the importance of areas with similar numbers of rare species.

For further research into rarity choosing major groups of plants will depend upon how rarity is assessed. If for example priority is based on the compositions of rare species the major taxa to be investigated are

Myrtiflorae	15% (ie 15% of rare Australian species are myrtles)
Fabiflorae	12%
Proteiflorae	9%
Liliiflorae	8%
Malviflorae	8%
Commeliniflorae	7%
Rutiflorae	6%

If priority is based on percentage rarity within superorders, major taxa to be investigated are

Areciflorae	37% (ie 37% of palms are rare)
Myrtiflorae	34%
Proteiflorae	33%
Magnoliiflorae	33%
Rutiflorae	32%
Zingiberiflorae	32%
Corniflorae	30%

If priority is to be based on a combination of both above criteria major taxa requiring investigation are Myrtiflorae, Proteiflorae and Rutiflorae.

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